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JAPANESE TUNA-MOTHERSHIP EXPEDITIONS IN THE WESTERN EQUATORIAL PACIFIC OCEAN

(June 1950 to June 1951)

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INTRODUCTION

The American fishing industry has watched with increasing interest the Japanese mothership-type fishing expeditions conducted in the waters of the Trust Territory of the Pacific Islands in the western Pacific. Much of the fish brought back from these expeditions has been exported to the United States as a finished canned product or frozen in the round for canning by American firms. Numerous questions regarding these expeditions have been directed to the Pacific Oceanic Fishery Investigations of the U. S. Fish and Wildlife Service, which has supplied the biological observers who accompanied most of these expeditions. This report will present the data available on the operations, catch, and proceeds of the first six expeditions, which were conducted from June 1950 to June 1951. It will supplement a previous report by Bell M. Shimada (1951) on the first expedition in which he gives many details of equipment, vessel construction, and operating techniques.

Statistical data on the catch, effort, and price received by each expedition were furnished by the Japanese Government through SCAP. Supplementing these data are the observations of U. S. Fish and Wildlife Service representatives who accompanied the first, third, fourth, and fifth expeditions.

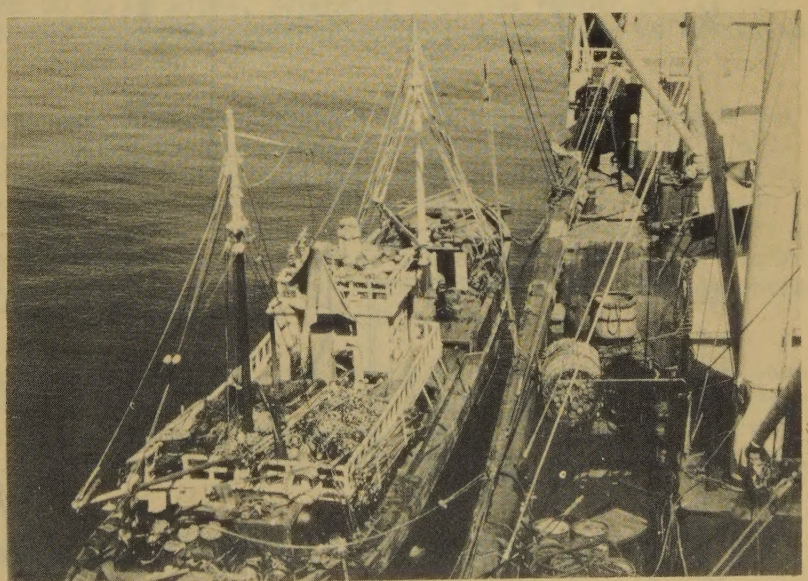

FIG. 1 - A JAPANESE TUNA CATCHER BOAT TIED UP TO A MOTHERSHIP.

All of these expeditions were organized and conducted in compliance with SCAP Directive No. 2097 issued on May 11, 1950, which authorized Japanese tuna-fishing vessels to extend their activities to certain areas in the vicinity of the Caroline, Mariana, and Marshall islands for the first time since the war. The exacting terms and conditions under which the extension was granted and the areas of operation prescribed are stated in Weekly Summary No. 239 issued in May 1950 by the Natural Resources Section, GHQ, SCAP (1950). In brief, the directive provided that records of the fishing and fish catches must be kept, that a representative of the Supreme Commander for the Allied Powers (SCAP) accompany each expedition, that provision

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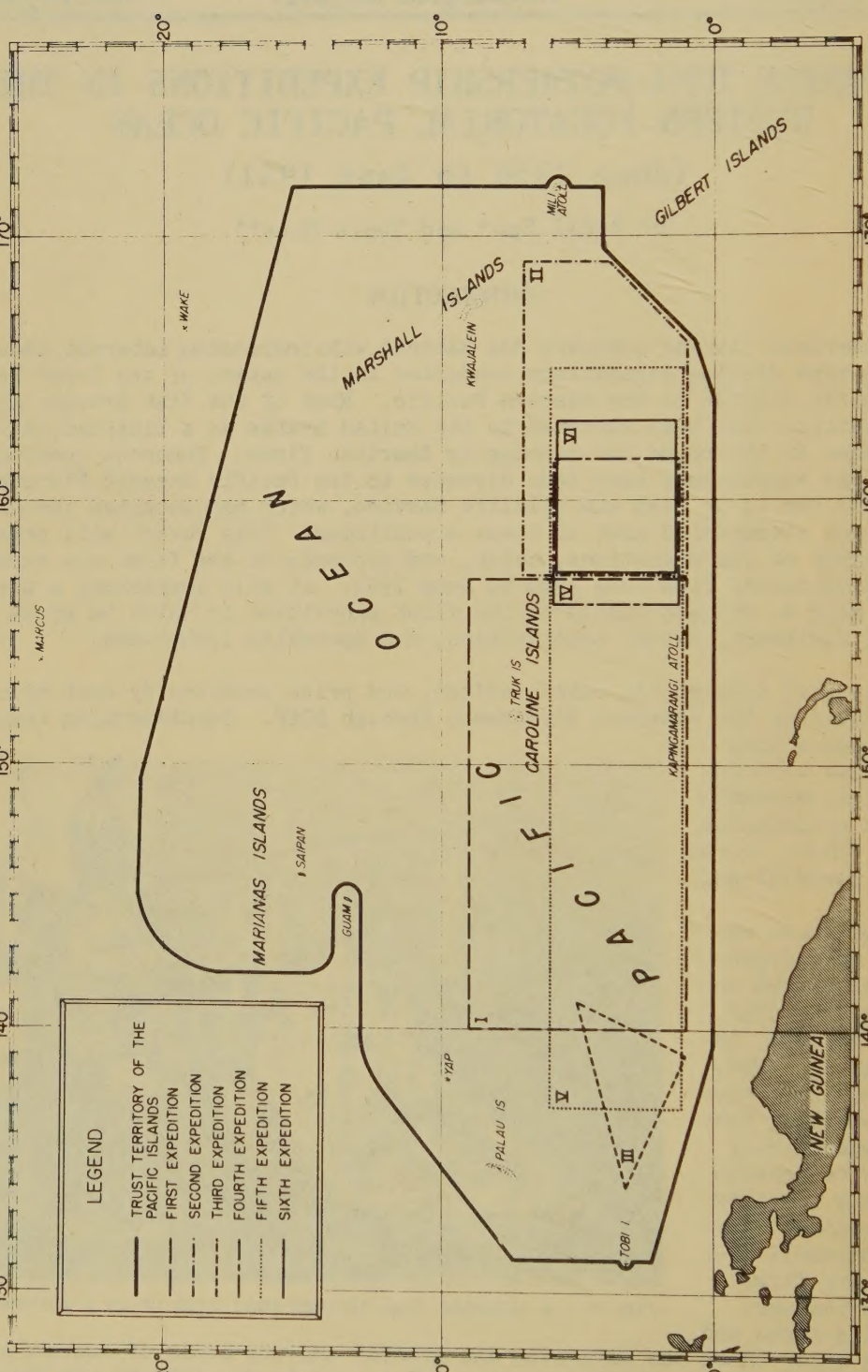

FIG. 2 - THE U.S. TRUST TERRITORY OF THE PACIFIC ISLANDS AND THE AREA FISHED BY EACH OF THE FIRST SIX JAPANESE MOTHERSHIP EXPEDITIONS FOR TUNA IN 1950 AND 1951. ALTHOUGH SOME OF THE EXPEDITIONS FISHED AS FAR NORTH AS 90 N. LATITUDE, MOST OF THE FISHING WAS DONE SOUTH OF 5° N. LATITUDE.

be made for a representative of the High Commissioner of the Trust Territory of the Pacific Islands and the U. S. Fish and Wildlife Service to board or accompany vessels of any expedition for purposes of observation and inspection, that daily radio reports be made of the positions of all vessels, that no vessel of the expedition approach closer than 3 miles to any land not under the administrative control of the Japanese Government, and that all operations be supervised by responsible Japanese officers.

The first six expeditions organized under this SCAP directive differed greatly in the scale of their operations. The Taiyo Fishing Company, Limited, one of the largest fishing concerns in Japan, owned the large whaling motherships Tenyo Maru No. 2 and Tenyo Maru No. 3, which were sent out on the first and fifth expeditions during the off-season for whaling. The second expedition, organized by the Hoko Suisan Company, chartered another large mothership, the Kaiko Maru, from the Nippon Suisan Company. These expeditions were in contrast with the third, fourth, and sixth expeditions organized by the Nansei Fisheries Co., Ltd., which used much smaller motherships. One was the large trawler Tenryu Maru, and another was a chartered auxiliary mothership, the Tosui Maru, which had been a coastwise carrier.

Almost all of the more than 20 million pounds of fish caught on these several expeditions was taken by long-line fishing. The details of the gear and method of operation in this type of fishing are given by Shimada (1951) and by Shapiro (1950) and need not be repeated here.

OPERATING RESTRICTIONS AND CONTROL

The SCAP representatives and the officers of the Japanese Fisheries Agency sought to insure compliance with the SCAP directives. All fishing vessels were ordered to keep a prescribed distance inside the boundaries of the authorized area. This distance ranged from 20 to 60 miles, depending upon the number of fishing vessels in an expedition and upon the degree of control which could be maintained over them.

Similarly, no fishing was permitted within 5 to 10 miles of any island and all fishing vessels were required to operate within a 200-mile radius of a midpoint, the latter being either the mothership or a stated geographical position. Vessels desiring to fish beyond the 200-mile radius could apply for permission to do so, the granting of which depended upon existing circumstances and was left to the discretion of the SCAP representative. By the use of radio direction finders aboard the mothership and the Japanese fishery inspection vessel, frequent checks of the fishing vessels' positions were made on each expedition.

To further insure maximum compliance with SCAP directives, daily radio contacts were maintained between the mothership and each fishing vessel at predetermined hours. The fishing vessels were required to transmit details of each day's activities, noon positions, direction in which the long lines were set, and estimates of their daily catches.

FISHING AREA AND PERIOD OF OPERATION

The extent of the grounds covered by an expedition varied from 300 to 1,700 miles in an east-west direction and from 240 to 500 miles in a north-south direction. Vast areas were traversed by the larger expeditions, which carried an adequate store of fuel and provisions, while the smaller expeditions with limited facilities fished in relatively small areas (table 1).

Details of the fishing area and period of operation for the first expedition have been given by Shimada (1951) and are summarized in table 1.

Table 1 - Size, Operating Area, and Period of the Japanese Tuna-Mothership Expeditions in the Western Equatorial Pacific Ocean (June 1950-June 1951)

Expedition	Motherships		No. Catcher Vessels	Area Fished	Period Fished
	Name	Gross Tonnage (Metric tons)			
I	Tenyo Maru No. 2	10,619	25	1°-9°N. lat.; 140°-157°E. long.	June 17, 1950 - September 5, 1950
II	Kaiko Maru	2,940	13	1°-7°N. lat.; 157°-169°E. long.	July 20, 1950 - September 30, 1950
III	Tenryu Maru	577	6	1°-5°N. lat.; 134°-141°E. long.	December 1, 1950 - December 26, 1950
IV	Tenryu Maru Tosui Maru	577 362	11	1°-6°N. lat.; 156°-161°30'E. long.	February 1, 1951 - February 24, 1951
V	Tenyo Maru No. 3 Banshu Maru No. 35	3,689 999	16	1°-6°N. lat.; 137°-165°E. long.	March 21, 1951 - June 13, 1951
VI	Tenryu Maru Tosui Maru	577 362	8	1°-6°N. lat.; 157°-163°E. long.	April 22, 1951 - May 25, 1951

The 13 catchers of the second expedition fished in an area bounded by 1°00' and 7°00' N. latitude and 157°00' and 169°00' E. longitude. Fishing began on July 20 and ended on September 30, 1950.

During the third expedition, which was accompanied by the senior author, fishing operations were confined within a triangle having points at 3°10' N. latitude, 134°00' E. longitude; 1°00' N. latitude, 139°00' E. longitude; and 5°00' N. latitude, 141°00' E. longitude. The first catcher commenced fishing on December 1, while the sixth and last catcher vessel to arrive on the fishing grounds began operation on December 15, 1950. The first fishing vessel which caught a full load of fish after having unloaded a prescribed amount to the mothership, departed for Japan on December 20. On December 26 fishing was terminated and all vessels still present on the fishing grounds proceeded to their home ports.

The area covered during the fourth expedition (also accompanied by the senior author) was bounded by 1°00' and 6°00' N. latitude and by 156°00' and 161°30' E. longitude. Operations were begun on February 1, 1951, and by February 8 the eleven fishing vessels and the two portable catcher boats comprising the entire fishing potential of the expedition were actively fishing. On February 16 the first catcher vessel departed for Japan. On February 24 all fishing activities were officially concluded and all vessels present on the fishing ground proceeded to Japan.

Fishing activities of the fifth expedition (accompanied by the junior author) were first conducted in an area of 200-mile radius with the midpoint at 4°00' N. latitude and 140°00' E. longitude. The general plan of operation was to start here and gradually move eastward as a unit, thereby covering as wide an area of the equatorial countercurrent region as possible. The speed of this eastward movement depended largely on the results shown by catcher vessels along the way. The expedition fished as far east as the 165th meridian and between 1°00' and 6°00' N. latitude. The first two catchers to arrive on the fishing grounds commenced fishing on March 21, 1951, and the entire fleet of 15 boats was in operation by April 12. Fishing was terminated on June 13.

The fleet of the sixth expedition arrived on the fishing grounds while the fifth was in the midst of operation. Since it was not accompanied by a SCAP representative, the sixth expedition was attached to the fifth for administrative

control. It fished between April 22 and May 25, 1951, in an area adjacent to the fleet of the fifth expedition.

FLEET COMPOSITION

The vessels utilized as motherships in these expeditions ranged in size from the 577-ton Tenryu Maru to the 10,000-ton Tenyo Maru No. 2. Correspondingly, the number of catcher vessels in the fleets varied from 6 to 25, with the larger fleets accompanying the larger motherships. The Taiyo Fishing Company, as one of the largest and most active fishing concerns in postwar Japan, had the necessary resources and facilities to engage in the more elaborate operations. The company was able to redeploy its large refrigerated carrier ships, which are normally used in the Antarctic whaling expeditions, to tuna fishing activities during the slack whaling seasons.

On the other hand, the Nansei Fisheries Company is primarily a trawl fishing concern. The major trawling grounds located in the East China Sea and most of the other grounds formerly exploited by the company have been closed to Japanese fishing since the war. The grounds still open to Japanese trawling have been exploited to such an extent that trawling operations in those waters have become barely profitable. Consequently, when the opportunity arose to engage in the tuna-fishing industry, this fishing company, though poorly equipped for such an undertaking, focused its attention in that direction. Its expeditions have been small in scale and of short duration.

Complete data on the fleets are available only for the expeditions which were accompanied by an observer. Hence the following discussion will briefly describe the composition of the third, fourth, and fifth expeditions, of which the first two were operated by the Nansei Fisheries Company and the last by the Taiyo Fishing Company.

The Tenryu Maru, a steel trawler of 577 gross tons with an over-all length of 176 feet, a beam of 26.9 feet, and a molded draft of 14.8 feet, was used as the mothership for the third and fourth expeditions. She is powered with a six-cylinder Diesel engine of 510 hp. In converting the Tenryu Maru from a trawler to a tuna-fishing mothership, no major changes were made. The only addition was the installation of a pair of boat davits against the starboard bulwark of the forward well deck for the hoisting and lowering of the two portable catcher boats which were transported to and from the fishing grounds on the fourth expedition. On the third expedition the total complement of men aboard the mothership numbered 37, while on the fourth expedition there were 58 men aboard.

The task of organizing and conducting the third and fourth expeditions was undertaken by the Nansei Fisheries Company, Ltd. Of the vessels participating in the third expedition, the Tenryu Maru was the only one owned and operated by the fishing company. All six catcher vessels in the third expedition were independently owned and operated.

In addition to the Tenryu Maru, the Tosui Maru, which was chartered from the Totsu Fisheries Corporation by the Nansei Fisheries Company, was used as an auxiliary mothership for the fourth expedition. The Tosui Maru, a 362-gross-ton vessel with an over-all length of 150.3 feet, a beam of 24.3 feet, and a draft of 13.8 feet, was primarily designed and normally operated as a coastwise carrier. The carrying capacity of the vessel is estimated at 125 metric tons of iced fish. The total number of men aboard the auxiliary mothership was 22.

Of the 11 catchers participating in the fourth expedition, 3 belonged to prefectural fisheries experiment stations, 1 belonged to the Nansei Fisheries Company, and the rest were owned by other fishing companies. Two of the prefectural vessels carried regular crews of professional fishermen while the third carried 25 students from the Yaizu Fishery College, in addition to a crew of experienced commercial fishermen.

On the fourth expedition, two portable catcher boats of 5 gross tons each, 27.9 feet in length, and 7.7 feet in beam, were transported to and from the fishing grounds aboard the Tenryu Maru. These portable boats were constructed of wood and powered with hot-bulb engines of 15 hp.

With the exception of the portable catcher boats, all vessels participating in the third and fourth expeditions were constructed of steel and were powered with 4-cycle Diesel engines. The fishing vessels were either specially designed long-line vessels or were combination skipjack (live-bait) and long-line vessels. A detailed description of a typical long-line vessel is given by Shimada (1951). Lists of boats and further particulars of the vessels in these expeditions are given in table 2.

Table 2 - Particulars of Catcher Vessels in the Third, Fourth, and Fifth Japanese Tuna-Mothership Expeditions

Name of Vessel	Gross Tonnage (Metric tons)	Maine Engine hp.	Construction	Date of Construction	Number in crew
THIRD EXPEDITION:					
Azuma No. 11	144	320	steel	1947	23
Gohuku No. 1	168	320	"	1948	24
Seiju No. 3	153	250	"	-	-
Seisho No. 1	179	380	"	1949	30
Shinko No. 30	150	250	"	-	-
Taihei	146	300	"	1937	25
FOURTH EXPEDITION:					
Asahi	145	250	"	1947	24
Chyokyu	196	400	"	1946	34
Fuji	191	380	"	1950	1/51
Hakutaka	131	320	"	1946	24
Nikko No. 11	165	350	"	1948	31
Ruson	100	210	"	1932	22
Sagami	167	380	"	1949	26
Seisho No. 1	179	380	"	1949	29
Seiyo No. 2	144	250	"	1946	25
Shiratori	158	400	"	1948	25
Taihei	146	300	"	1937	22

Name of Vessel	Gross Tonnage (Metric tons)	Main Engine hp.	Construction	Date of Construction	Number in crew
FIFTH EXPEDITION:					
Asahi	60	210	wood	1947	18
Asahi No. 7	84	160	"	-	16
Asahi No. 12	57	160	"	-	18
Azuma No. 1	138	320	steel	-	24
Azuma No. 2	139	320	"	1947	24
Azuma No. 3	147	320	"	1947	25
Azuma No. 5	146	320	"	1947	25
Azuma No. 7	145	320	"	1947	24
Kuroshio No. 10	170	250	"	-	24
Nankai No. 2	76	160	wood	-	18
Sasayama No. 7	158	320	steel	-	23
Seiju No. 3	153	250	"	-	26
Seiju No. 7	153	250	"	-	24
Tairyo No. 23	56	115	"	-	17
Tairyo No. 31	56	160	"	-	16
Tairyo No. 38	56	115	"	-	18

1/ A FISHERIES TRAINING VESSEL WITH 25 STUDENTS IN ADDITION TO THE REGULAR CREW.

The mothership of the fifth expedition, the Tenyo Maru No. 3, of 3,689 gross tons and 2,868 net tons, with a length between perpendiculars of 327 feet, a molded beam of 49 feet, and a molded draft of 26 feet, was powered by a 2,250-hp. main Diesel engine, two 450-hp. and one 100-hp. auxiliary Diesel engines. Three 50-ton freezing machines operated its refrigeration system. Personnel numbered 142 men.

An auxiliary refrigerated carrier, the Banshu Maru No. 35, arrived on the fishing grounds on April 21, 1951, to transport approximately 500 metric tons of frozen fish back to Japan. This vessel delivered fresh provisions in addition to fuel and ice, and relieved the mothership of the task of providing catcher vessels with crushed ice, until her departure on May 16.

The fifth expedition started out with fifteen catcher vessels ranging in size from 55 to 170 gross tons; later in the season another vessel joined the fleet. However, in mid-season, a 55-ton steel catcher, the Tairyo Maru No. 38, ran aground on a reef during a storm at Kapingamarangi Atoll (1°05' N. latitude-154°48' E. longitude) and had to be abandoned. The expedition suffered a second mishap on June 14, 1951, when a 145-ton catcher, the Azuma Maru No. 7, struck a reef south of Truk (7°06' N. latitude-151°55' E. longitude) while proceeding to Japan. This vessel, too, had to be abandoned although a large part of the fishing gear and other removable equipment was salvaged.

With the exception of the Kuroshio Maru No. 10, which belonged to the Nichiro Fisheries Company, all of the 16 catcher vessels participating in this expedition belonged to the Taiyo Fishing Company. Four catcher vessels in the 55- to 85-gross-ton class were of wooden construction, all others being of steel.

MOTHERSHIP'S RELATION TO THE EXPEDITION

Since maximum compliance with SCAP directives can be maintained most effectively aboard a central control vessel capable of housing the necessary supervisory personnel and equipped with a radio direction finder and a communication system powerful enough to contact the home port as well as each vessel in the fleet, authorization to fish in the U. S. Trust Territory has been given only to fleets accompanied by suitable motherships. Any vessel meeting SCAP specifications was permitted to serve as a mothership.

The size of the vessel determined to a large degree the extent of operations possible for the fleet of the expedition. A small mothership with its limited facilities was unable to support a fleet for any extended period, while a large mothership was able to serve as a supply and storage center for its fleet over a longer period.

The small mothership Tenryu Maru was found to be adequate for purposes of control; however, in a logistic sense it left much to be desired. The ship could supply only very small quantities of fuel, ice, water, and food to the catcher vessels. Consequently, all catchers participating in the third and fourth expeditions were forced to be nearly self-sufficient.

A water-evaporating apparatus was not installed aboard the mothership and, since the capacity of the water tanks was only 70 metric tons, no fresh water was supplied the catcher vessels. With strict rationing, about 50 tons of fresh water were consumed aboard the mothership on each of the two expeditions.

The capacities of the fuel tanks aboard the mothership totaled 141 metric tons. On the third expedition, 45 tons of Diesel oil were used by the mothership and 9 tons were sold to the catchers; while on the fourth, 82 tons were used by the mothership and 40 tons were sold to the catchers.

Two holds located below the forward well deck were used for ice en route to the fishing grounds, and subsequently for fish. Most of the 120 tons of ice was used by the mothership for packing fish, although a few tons were sold to the catchers. The total fish-carrying capacity of the holds was estimated at 175 metric tons.

The Tenyo Maru No. 3 of the fifth expedition, with its relatively large deck space and the refrigeration facilities necessary in the processing and transporting of whale meat, was found to be quite satisfactory in its new role as mothership of a tuna expedition. The fleet worked as a closely-knit unit, with the catcher vessels necessarily dependent upon the mothership for their supply of fuel, bait, water, ice, and provisions in such an extended operation. The three refrigerated storage holds of the mothership had an estimated capacity of more than 1,000 metric tons of frozen fish. The 947 tons of fresh water carried to the fishing grounds and the additional 500 tons produced by distillation were sufficient for an expedition of this size. Catcher ships' water tanks, ranging from 3 to 10-ton capacity, were supplied with fresh water throughout the expedition. Upon leaving Japan, the cargo holds were loaded with 891 tons of ice in 200-pound blocks. With the delivery of an additional 366 tons by the Banshu Maru No. 35 in mid-season, 1,257 tons of ice were utilized by the 16 catcher vessels in the 85 days of

fishing. The catcher vessels and the inspection vessel were supplied with approximately 415 tons of Diesel oil, while the fuel consumption by the mothership amounted to approximately 590 tons during the 108 days at sea. The fuel-tank capacity of the mothership was approximately 1,250 tons.

WORKING AGREEMENT

On the third and fourth expeditions the Nansei Fisheries Company supplied the mothership and made the following agreement with the independently-owned catcher vessels:

(a) "Each catcher vessel will deliver a minimum of 2,500 kan (20,668 lbs.) of fish in prime condition to the mothership while on the fishing ground.

(b) "In the event that delivery of the allocated amount of fish is not feasible due to accidents or unavoidable difficulties, the owner of the catcher vessel will pay the Nansei Fisheries Company, Ltd., an amount of money corresponding to the allocated amount of fish. This reimbursement will be made after the vessel's return to Japan and will be based on the average ratio of delivery made by the rest of the vessels in the fleet.

(c) "Should the catcher vessel fail to realize any catch or should the catch be comparatively small, the Nansei Fisheries Company, Ltd., and the owner of the catcher vessel will negotiate for an equitable adjustment upon the return of the vessels to Japan.

(d) "Of the amount allocated, sharks will not comprise more than 10 percent of the total load of fish delivered to the mothership.

(e) "Regardless of fish species, the purchase price of the minimal delivery of 2,500 kan of fish will be 100 yen per kan (3.4 cents per pound).

(f) "Upon delivery of more than 2,500 kan of fish, price adjustments, mutually satisfactory to both parties concerned, will be made between the general manager of the mothership and the captain of the catcher vessel.

(g) "The mothership will supply 5 tons of fuel oil per boat at the original price.

(h) "In the event that unforeseen complications arise, negotiations and adjustments will be made by the fishing company and the catcher ship owner in the presence of a representative from the Fishery Agency."

The Taiyo Fishing Company, Ltd., which owned and operated most of the vessels in the fifth expedition, drew up the following contract with the fishermen:

(a) "The fishermen of a catcher vessel to be reimbursed with 40 percent of the profit derived by that vessel after deducting trip expenses from the total proceeds realized.

(b) "The boat owner to receive the remaining 60 percent.

(c) "A minimum guarantee of 8,000-15,000 yen (US $22.00-$42.00) per month will be made to the individual fisherman, the amount depending upon his experience and rank.

(d) "The top prices to be paid by the mothership for the different species of fish will be:

Species	Cents Per Pound[1/]
Yellowfin tuna	7.0
Spearfishes, big-eyed tuna, albacore	5.4
Wahoo	5.0
Skipjack tuna	4.4
Barracuda, others	2.7
Sharks	2.0

1/ YEN PER KAN WERE CONVERTED TO CENTS PER POUND BY USING THE CONVERSION FACTORS OF 1 KAN = 8.267 POUNDS AND 360 YEN = $1.00.

"At the mothership each fish will be classified into a grade according to its condition. Prices will differ for the different grades of fish."

FISHING METHODS

Unlike the first expedition, where the long-line method of fishing was augmented by pole-and-line fishing for surface schools of fish, only the long-line was used in the other expeditions. This is a drifting long-line designed to fish at subsurface levels for tunas, spearfishes, and other large pelagic fish. The main line is suspended at 150- to 175-fathom intervals with 9- to 17-fathom float lines attached to glass floats 9 to 12 inches in diameter. Between floats, 5 to 6 dropper lines of 8 to 11 fathoms in length are hung from the main line at equal intervals. The hooks are usually baited with frozen sauries (Cololabis saira) or sardines (Sardinia melanosticta). In one day's fishing a catcher vessel of the

130-ton class may set 300 to 350 baskets in one continuous connected line with 1,600 to 1,800 hooks.

For further particulars on the long-line gear, refer to Shapiro's (1950) report on the Japanese long-line fishery and Shimada's (1951) account of the first mothership-type tuna expedition. The developmental history of the long-line and details of the construction and use of the gear are given by Shapiro. Shimada describes in full the construction of the gear and the technique of setting and retrieving the gear as well as other operational aspects of a typical long-line vessel.

FISH CATCH

The catch composition by species was similar for all six expeditions. The tunas included the yellowfin tuna (Neothunnus macropterus), big-eyed tuna (Parathunnus sibi), albacore (Thunnus germo), oceanic skipjack (Katsuwonus pelamis), and an occasional black tuna (Thunnus orientalis). Of the spearfishes caught, the species included the black marlin (Makaira mazara), white marlin (Makaira marlina), striped marlin (Makaira mitsukurii), sailfish (Istiophorus orientalis), short-nosed spearfish (Tetrapterus brevirostris), and broadbill swordfish (Xiphias gladius). The miscellaneous varieties of fish which constituted a small percentage of the catch consisted of the barracuda (Sphyraena sp.), wahoo (Acanthocybium solandri), and the dolphin (Coryphaena hippurus). Among sharks included in the catch were the mackerel shark, the hammerhead shark, the great blue shark, the thresher shark, and another fairly common species known by the Japanese as the hiragashira, probably belonging to the genus Scoliodon.

Yellowfin tuna was the species sought and found to be abundant in the waters of the Trust Territory. In each of the six expeditions this species constituted the major portion of the total catch, amounting to about 60 percent of the total by weight.

The big-eyed tuna also was an important constituent of the catch, being second to yellowfin among the tunas caught. This species averaged a little over 10 percent, both by weight and number, of the total catches made during the six expeditions.

Among the spearfishes, the black marlin was predominant and was next to the yellowfin tuna in number and weight. Further details of the catch composition by

Table 3 - Japanese Tuna-Mothership Expeditions--Total Catch and Average Weights (in pounds) by Species

Species	EXPEDITIONS											
	First		Second		Third		Fourth		Fifth		Sixth	
	Total	Avg.	Total	Avg.	Total	Avg.	Total	Avg.	Total	Avg.	Total	Avg.
Yellowfin tuna	4,572,698	75	3,246,486	101	395,889	67	805,609	78	2,362,692	74	710,739	75
Big-eyed tuna	698,761	80	396,913	98	58,279	90	138,979	96	863,066	86	158,597	98
Albacore	65,355	45	24,223	48	8,027	42	10,015	46	11,706	48	888	36
Black tuna	3,428	343	-	-	-	-	-	-	727	364	-	-
Skipjack tuna	6,966	8	16,671	12	1,234	9	502	7	835	10	2,540	7
Black marlin	1,759,751	131	1,447,517	149	72,609	117	295,098	132	658,987	131	211,412	125
White marlin	48,164	171	2,486	166	5,493	172	7,966	150	20,932	146	2,273	126
Sailfish 1/	28,150	44	11,901	32	3,156	40	8,605	37	35,002	37	10,818	39
Swordfish	13,651	76	6,308	91	3,656	58	2,363	98	11,640	85	3,576	102
Striped marlin	1,228	123	1,605	123	190	80	231	116	521	87	370	123
Sharks	894,698	56	402,518	72	37,025	94	28,917	73	385,738	66	41,746	69
Others 2/	23,045	28	21,298	29	4,095	18	12,234	23	23,396	19	16,604	23
Total	8,115,895		5,577,926		589,653		1,310,519		4,375,244		1,159,563	

1/ INCLUDES SHORT-NOSED SPEARFISH (TETRAPTERUS BREVIROSTRIS).
2/ INCLUDES MISCELLANEOUS SPECIES, SUCH AS WAHOO, DOLPHIN, AND BARRACUDA.

species are found in table 3. Also included in table 3 are the average weights, by expeditions, of the various species of fish caught.

VARIATIONS IN FISHING SUCCESS

From the data obtained in the prewar Japanese surveys of the waters of their former Mandated Islands (present Trust Territory), Nakamura (1943) reported a catch per 100 hooks per day of 6.05 tunas and marlins from the area between 0° and 5° N. latitude and 130° and 180° E. longitude. For the same period, he reported 1.70 tunas and marlins caught per 100 hooks from waters north of 5° N. latitude. Yellowfin tuna was found to be most abundant in the catch followed by the black marlin and the big-eyed tuna. Nakamura has concluded that, in general, the yellowfin tuna is most abundant in the equatorial countercurrent and particularly south of 5° N. latitude.

The postwar tuna expeditions, while fishing north to 9° N. latitude, have confined most of their fishing activities to the south of 5°. The results obtained did not vary greatly from one expedition to the other, the average for all six

Table 4 - Catch Rates of Japanese Tuna-Mothership Expeditions

Species	NUMBER OF FISH CAUGHT PER 100 HOOKS PER DAY FISHED					
	E X P E D I T I O N					
	First	Second	Third	Fourth	Fifth	Sixth
Yellowfin tuna	2.28	2.50	3.38	2.71	2.24	2.49
Big-eyed tuna	0.33	0.32	0.37	0.38	0.70	0.43
Albacore	0.05	0.04	0.11	0.06	0.02	<0.01
Black tuna	<0.01	-	-	-	<0.01	-
Skipjack tuna	0.03	0.11	0.08	0.02	<0.01	0.09
Black marlin	0.50	0.76	0.36	0.59	0.35	0.45
White marlin	0.01	0.01	0.02	0.01	0.01	<0.01
Sailfish and Shortnosed spearfish	0.02	0.03	0.04	0.06	0.07	0.07
Broadbill swordfish	<0.01	0.01	0.04	0.01	0.01	<0.01
Striped marlin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sharks	0.60	0.44	0.23	0.10	0.41	0.16
Others	0.03	0.06	0.13	0.14	0.08	0.19
Tunas and marlins	3.23	3.77	4.40	3.84	3.40	3.55
Total	3.85	4.27	4.76	4.08	3.89	3.89

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being 3.70 tunas and marlins caught per 100 hooks. The fourth expedition achieved the highest ratio of 4.40 while the first recorded the lowest of 3.23. Table 4 lists the catch per 100 hooks for the different species in each of the expeditions.

Without knowing whether the prewar Japanese data are exactly comparable, it is probable that the catches of the present expeditions are at a comparatively low level. It must be realized that this fishery was not exploited during World War II, a situation in which one would normally expect an increase in catch in the period immediately following. This difference between the two periods was noticed by the Japanese fishermen, who attributed it to a decrease in the abundance of the tuna stocks (Shimada 1951).

UNLOADING

During the third and fourth expeditions most of the fishing vessels unloaded only the minimum quantity of 2,500 kan (20,600 pounds) of fish that was stipulated in the agreement. In view of the fact that fish landed during the earliest part of the expedition would be fish stored for the longest period of time, and thus

presumably in the poorest condition when brought back to Japan, the fishing vessels tended to discharge their catches aboard the mothership as soon as 2,500 kan of fish were caught. Since the catchers did not arrive on the fishing grounds and begin fishing on the same date, the first deliveries were reasonably well spaced so that the mothership was able to handle them without delay. A strict unloading schedule for each catcher was found to be unnecessary. The fishing vessel desiring to discharge her catch contacted the mothership by radio and made arrangements for a rendezvous. Whenever possible, the mothership ran half the distance to the catcher vessel.

In the fifth expedition, with the exception of a few tons of fish caught during the last days of the operation, the entire landings made by the fishing vessels were transferred to the mothership. Since there were only 15 active catcher vessels, the processing of one or two vessels per day sufficed and resulted in a smooth unloading operation. A flexible schedule maintained by the mothership often permitted the catcher vessels to change the unloading date to the most suitable day. Usually a fishing vessel unloaded her catch after 8 to 10 days of active fishing.

FIG. 3 - YELLOWFIN TUNA ABOUT TO BE TRANSFERRED TO A JAPANESE TUNA MOTHERSHIP.

Unlike the motherships of previous expeditions, the Tenyo Maru No. 3 of the fifth expedition was given a greater degree of freedom in its movements, since it was not required to serve as the midpoint of catcher-ship operation. As a result of this change, the mothership was often able to make a run to the catcher vessel desiring to unload her fish. This arrangement saved many hours of valuable fishing time for the fishermen. The 16 catcher vessels present in the fifth expedition seemed to be the optimum number that a mothership of around 3,000 tons could efficiently handle on an extended fishing trip. Enough fish was received daily to keep the refrigeration facilities in constant operation. The processing crew aboard the mothership were kept occupied throughout the day, but they generally received sufficient hours of rest so that high morale was maintained.

On all expeditions the transfer of fish and supplies was made out in the open sea. Fortunately, wind forces from dead calm to gentle breeze predominated throughout the operations in the lower latitudes. In taking fishing vessels alongside, the mothership of every expedition drifted with the prevailing wind and swell broad on the beam. The catcher vessel came in from aft along the lee of the mothership. Bow and stern lines, usually in conjunction with spring lines, were used to secure the catcher alongside the mothership in position to unload with the forward well deck of the catcher abreast of the processing deck of the mothership.

In the expeditions using motherships of 3,000 tons or larger, the mooring operation presented no great problem. However, during the third, fourth, and sixth expeditions, in which a mothership of 577 gross tons was used, the difficulties entailed in providing safe moorage for the catchers were such that several Japanese fishing experts believed it doubtful if not impossible that successful mooring and unloading operations could be conducted by the Tenryu Maru on the high seas.

Although ideal wind and sea conditions prevailed throughout the operations, as was predicted, oftentimes excessive rolling of both the mothership and the

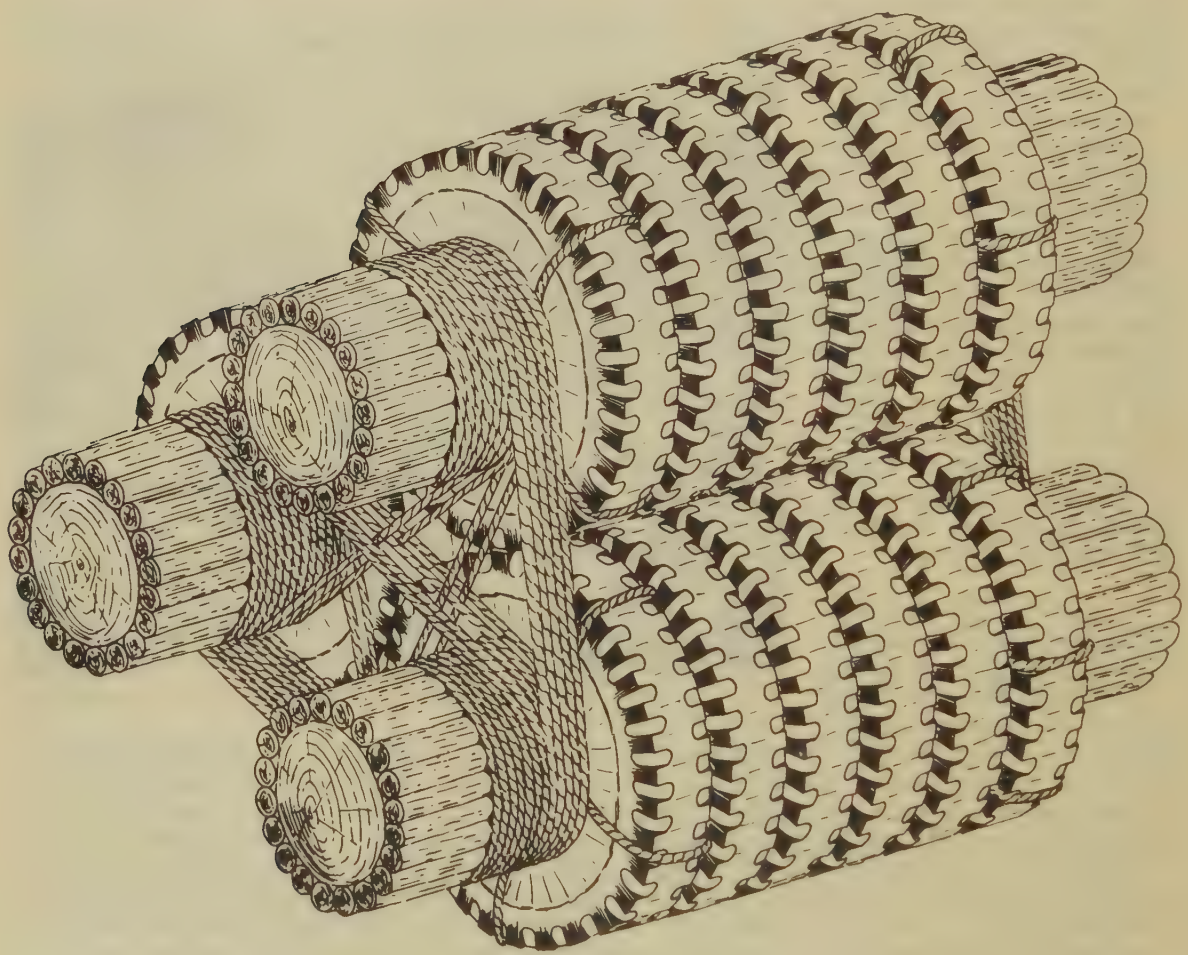

FIG. 4 - DIAGRAM OF A TRIPLE-FENDER USED DURING THE FOURTH JAPANESE TUNA MOTHERSHIP EXPEDITION.

catcher was caused by swells. Despite the obstacles encountered, a highly satisfactory method of mooring the catcher vessels was developed. To a large degree, successful mooring operations and consequently the favorable outcome of the third, fourth, and sixth expeditions depended upon the strategic use of suitable fenders. Therefore, detailed descriptions of the use and construction of the fenders will be given.

The fenders used on the third expedition were made by passing a core of seasoned pine logs through the rim holes of six truck tires. By lashing the tires and logs together with manila and wire ropes, the component parts of the fenders

were secured. Two of these buoyant fenders were lowered, floated into place fore and aft, and secured to the mothership with loose bridles of wire rope before the catcher pulled alongside. In the first few trials it was found that the width of the fenders was insufficient to prevent bumping entirely.

In the second trial, a fender of double the width was made by lashing together two fenders. This arrangement, though much more satisfactory than a single fender, still did not eliminate all bumping. Normally, the double fender floated flat with the two sets of tires lying alongside each other; however, when both vessels surged together with too great a force, the fender rolled on its side permitting contact of the vessels.

On the fourth expedition the fenders evolved for the Tenryu Maru through experience gained in the previous expedition proved to be satisfactory in all ways. Basically, the fenders were constructed as before with six truck tires lashed around a core of seasoned logs. Three sets of these fenders were fastened together with wire rope into a cluster, making a single large fender which offered sufficient width at all times, regardless of the roll of the vessel or the fender. The triple fender was about 6 feet in width and 7 feet in length (figure 4). Two large triple fenders floated fore and aft prevented all bumping.

The fenders carried to the fishing ground by the Tosui Maru, the auxiliary mothership, though similar in design to those carried by the Tenryu Maru in the fourth expedition were built with a seemingly minor detail ignored which proved to be most costly. The core of wood which was stuffed through the rim holes of the tires consisted of unseasoned logs and strips of green bamboo which rendered the fender non-buoyant when placed in the water. During periods of excessive rolling, the fenders sank below the hull curvature of the catcher vessel. The weight of the catcher vessel riding on the fender parted the wire rope bridles in two successive trials. In the first parting, because of indecision and delay in casting off the fishing vessel, extensive damage was sustained by the auxiliary mothership and the catcher. The steel plates of the Tosui Maru were badly buckled and the outboard fishing rack of the catcher vessel was completely demolished at the point of contact. To continue unloading operations, two buoyant fenders were borrowed from the Tenryu Maru and the transfer of fish and supplies was completed without mishap.

With the exception of the auxiliary mothership, the Tosui Maru, all carrier vessels of the six expeditions used the yard-and-stay method for transferring fish and supplies from one vessel to another. Where the fixed derrick system was used, the manner of hoisting fish was found to be very similar to that described by Shimada (1951). Since the Tenryu Maru was equipped with only a single foremast cargo boom, the spring stay extending from the foremast to the mainmast was used in place of a hatch boom.

Aboard the Tosui Maru a slewing derrick was employed for transferring fish. The fish were raised and lowered by a whip connected to the drum of an electric deck winch. For slewing fish inboard, three men aboard the Tosui Maru manned a side guy while the outboard-swinging guy extended clear to the deck of the vessel unloading, where it was handled by three men. Working the outboard-side guy aboard the catcher vessel made it difficult and dangerous to control the slewing motion of the boom when the vessels swung or rolled badly. Also, the roll of the receiving vessel imparted a pendulum action to the single whip which often caused the cargo of fish to be slammed against the bulwarks.

Where ease of handling, economical use of manpower, safety, and speed are concerned in transferring cargo out in the open sea, the yard and stay method was found to be far superior to the slewing derrick system.

In the fifth expedition, crushed ice was supplied to the catcher vessels at the end of each unloading. This operation proved to be one of the most inefficient aspects of the entire mothership operation. The ice flowing from the ice crusher on the bridge deck down a 10-foot metal chute tended to pocket itself in the canvas sleeve attached to the end, and required at least three additional men to work the ice out. This stoppage at the canvas sleeve was largely caused by the insufficient incline of the chute from the crusher to the catcher vessel.

Some improvement was noticed when the canvas sleeve was discarded and the metal chute lengthened a few feet. However, even in the slightest sea, the catcher vessels rolled enough to cause the chute to pull away from the hatch, causing the ice to drop on the deck. Often the chute fell short of the catcher ship itself, and it required three men on the mothership tending side guys and the topping lift to prevent the chute from getting crushed between the two ships.

Under the best conditions, the mothership was able to deliver about 20 tons of ice in one hour.

HANDLING AND PROCESSING OF FISH

The major objective of the first, second, and fifth expeditions was to produce the greatest possible quantity of tuna frozen in the round for the export trade. For domestic consumption, a substantial part of the tuna catch which did not meet quality standards for whole freezing was processed into frozen fillets and the remainder was preserved in ice.

In contrast, most of the fish caught on the third, fourth, and sixth expeditions, conducted by the Nansei Fisheries Company, were slated for the fresh fish markets of Japan. These fish were iced rather than frozen. Considering the short duration of these expeditions, such a method of preservation was found to be adequate. Also, it is claimed that the flavor and texture of tuna and marlin which are to be consumed raw as "sashimi" are impaired by freezing.

Since the gills and viscera of the fish had been removed aboard the fishing vessels immediately after capture, the stowing of the whole fish aboard the Nansei Fisheries Company's receiving vessels was a relatively simple procedure. The fish were first hosed down with sea water and the blood and slime clinging to the external surface and the body cavity were scrubbed off with a deck brush. After weighing by species, several at a time, on a 500-kilogram, single beam, portable platform scale, the fish were lowered by hand into the storage holds.

In stowing the fish in ice the body cavity was packed with crushed ice and then the catch was covered with ice equivalent to the weight of the fish. Whenever possible, shark were stored in the bottom of the hold followed by marlin with tuna placed on top. Between layers about three fish deep, tiers of wooden partitions were placed to prevent crushing of the lowermost fish.

To prevent the rapid melting of ice aboard the Tenryu Maru, a 70-horsepower hot-bulb engine drove an ammonia compressor which by an indirect expansion system cooled the calcium chloride brine passing throught the coils installed on the top and all four sides of the fish holds. With this cooling system, a temperature of -2° to -5° C. (23° to 28° F.) was maintained in the holds.

As an experimental venture, a few tuna and marlin received aboard the Tenryu Maru during the fourth expedition were first immersed in -4° to -8° C. (18° to 25° F.) sodium-chloride brine for a period of 4 to 12 hours. After immersion in brine, the fish were packed in ice and stored in the hold containing the rest of the iced

fish. A few organoleptic examinations of these fish a week after being placed on ice showed very favorable results. The color as well as the texture and firmness of the flesh showed no perceptible difference from freshly caught fish. In addition, about 10 tons of yellowfin tuna were dry frozen in the forward fish hold where the temperature was maintained at -8° C. (18° F.). These fish were frozen as possible trial exports to canners in the United States.

The fish-handling and processing methods in the fifth expedition were very similar to those reported by Shimada for the first expedition. A full description will, therefore, not be necessary except for a brief account of the freezing details.

For fish to be frozen in the round, the Tenyo Maru No. 3 employed the method of brine-freezing and subsequent dry storage. Each of the three brine tanks measured 4 feet in width, 12 feet in length, and 5 feet in depth. The sodium-chloride brine solution was cooled to a temperature between -13° C. and -21° C. (-6° to 9° F.) by a system of herringbone ammonia coils. Each brine tank had a holding capacity of approximately 200 fish of 85 pounds average weight, the estimated total capacity of the three tanks being 22.5 metric tons.

The buoyant effect of the dense brine was overcome by using a makeshift press to keep the fish immersed during the freezing cycle. Three 2-hp. motors were used to circulate the brine in the tanks, thereby insuring a satisfactory heat exchange between the brine and the fish. Fish were kept in the brine for 16 to 26 hours, depending upon the number and size of fish being frozen, and were frozen to a mid-body temperature between -4° C. and -10° C. (14° to 25° F.). After reaching a suitable temperature, the fish were taken out of the brine, and stored in the cold-storage hold.

FIG. 5 - A WORKER FILLETING A YELLOWFIN TUNA ABOARD A JAPANESE TUNA MOTHERSHIP.

The quick-freezing chamber on the mothership was capable of handling approximately 16 tons of fillets at one time. The fillets required approximately 20-24 hours in the freezing chamber before being cooled to a temperature between -4° C. and -12° C. (10° to 25° F.). At this temperature the fillets were taken out of the chamber, removed from the pans by immersion in salt water, glazed in fresh water of 1° C. (34° F.), placed in cardboard boxes, and stored in the cold-storage hold. Other details are given in Shimada's (1951) report of the first expedition. The mothership was able to process approximately 38.5 tons of fish a day; 22.5 tons of fish to be frozen in the round, and the remainder in fish to be filleted.

PROCEEDS FROM SALE OF FISH

In all six expeditions the catcher vessels disposed of their catches by either transporting the fish back to Japan and selling them in the home market or by selling the fish directly to the mothership while out on the fishing grounds.

Table 5 - Total Proceeds Realized by Catcher Vessels[1] of the Japanese Tuna-Mothership Expeditions

Expedition	Disposition of Fish	TUNAS Weight (lbs.)	TUNAS Proceeds (US$)	TUNAS US Cents per lb.	MARLINS Weight (lbs.)	MARLINS Proceeds (US$)	MARLINS US Cents per lb.	SHARKS[2] Weight (lbs.)	SHARKS[2] Proceeds (US$)	SHARKS[2] US Cents per lb.	OTHERS Weight (lbs)	OTHERS Proceeds (US$)	OTHERS US Cents per lb.
I	Sold to Mothership	5,149,035	272,956	5.3	1,699,071	66,186	3.9	812,015	8,184	1.0	20,468	807	3.9
	Sold in Port[3]	198,173	30,265	15.3	151,874	21,314	14.0	82,682	4,211	5.1	2,577	226	8.8
II	Sold to Mothership	3,667,622	180,501	4.9	1,469,817	57,598	3.9	402,518	4,057	1.0	37,970	1,381	3.6
III	Sold to Mothership	59,646	3,004	3.4	7,982	268	3.4	6,196	198	3.2	154	5	3.2
	Sold in Port	403,785	52,020	12.9	77,122	7,918	10.3	30,830	1,034	3.4	3,942	190	4.8
IV	Sold to Mothership	276,003	15,195	5.5	133,239	6,270	4.7	16,346	490	3.0	4,816	120	2.5
	Sold in Port	679,113	91,394	13.5	187,012	24,214	12.9	11,735	407	3.5	6,505	458	7.0
V	Sold to Mothership	3,190,872	196,016	6.1	719,874	36,202	5.0	383,299	6,462	1.7	23,205	735	3.2
	Sold in Port	47,998	5,130	10.7	7,209	698	9.7	2,439	76	3.1	347	7	2.0
VI	Sold to Mothership	343,423	14,578	4.2	84,876	3,152	3.7	16,605	510	3.1	8,831	270	3.1
	Sold in Port	509,946	28,968	5.7	140,075	8,089	5.8	22,920	512	2.2	7,427	178	2.4
	TOTAL	14,525,616	889,027		4,678,151	231,909		1,787,585	26,141		116,242	4,377	

1/ STATISTICS PROVIDED BY THE JAPANESE FISHERY AGENCY AND CONVERTED INTO POUNDS AND DOLLARS, USING THE CONVERSION FACTORS OF 8.267 LBS. = 1 KAN AND US$1 = 360 YEN.
2/ MOST OF THE SHARKS CAUGHT DURING THE THIRD, FOURTH, AND PROBABLY THE SIXTH EXPEDITIONS WERE DISCARDED IN ORDER TO MAKE SPACE FOR MORE VALUABLE SPECIES AND ARE NOT INCLUDED IN THIS TABLE.
3/ SOLD IN PORT REFERS TO FISH WHICH WERE CARRIED BACK TO JAPAN BY THE VARIOUS CATCHERS AND SOLD TO THE HOME MARKETS.

In the Nansei-conducted expeditions, the bulk of the fish was brought back and sold in the Japanese ports by the catcher vessels themselves, while during the expeditions sponsored by the Taiyo and Hoko companies the greater part of the landings was delivered and sold to the motherships. Table 5 lists the disposition and the total proceeds realized by the catcher vessels of the various expeditions.

As stated previously, most of the catcher vessels of the Nansei expeditions delivered and sold to the receiving vessels only the minimum stipulated quantity of fish for 100 yen per kan (3.4 US cents per pound). The fish, if judged to be of a reasonable degree of freshness, were bought at this rate irrespective of species.

On the other hand, the Taiyo and Hoko motherships graded the fish by species and quality and paid for them accordingly. Table 6 gives the weights of each species of fish bought at the different prices by the Taiyo Company during the first expedition. It should be noted that most of each species sold for the top price.

Table 6 - Weights of Fish (in pounds) Sold to the Mothership at the Various Prices During the First Japanese Tuna-Mothership Expedition[1]

Categories	PRICE (US cents per pound) 6.0	4.4	4.0	3.7	3.4	3.0	2.7	2.4	2.0	1.7	1.3	1.0
Yellowfin (whole frozen for export)	2,346,010		1,104	3,927				308				
Yellowfin (filleted for domestic use)	1,040,488		3,010	8,324			7,186	1,118				
Yellowfin (miscellaneous for domestic use[2])	60,488	10,676	179,587	405,455	6,867	8,112	44,272	122,898	75,722	12,257	385	
Gills[3]	95,893											
Big-eyed tuna (filleted, iced)			577,302		61	274	4,300	39,849	4,549	742		
Small big-eyed tuna (frozen)					44		3,770	325	914	754		
Albacore (whole frozen for export)	40,572		141		1,166		13,930	703	480			
Skipjack tuna			1,543	18	588	997	502	655	1,608	78		
Black tuna			3,089									
Black marlin			1,461,984		2,086	6,514	101,242	10,345	25,691	3,324		
White marlin			34,340		160		7,501	1,355	1,227	42		
Striped marlin			1,085									
Sailfish			21,302		531	382	394	204	966	1,506	278	170
Swordfish			7,960		2,857	138	785	124	921	84	78	25
Sharks												804,830
Others[4]			19,147		263	70	209	12	448	180		

1/ STATISTICS OBTAINED FROM TAIYO FISHING COMPANY THROUGH BELL M. SHIMADA. YEN PER KAN CONVERTED TO CENTS PER POUND BY USING THE CONVERSION FACTORS OF 8.267 LBS. = 1 KAN AND US$1 = 360 YEN. THE WEIGHTS GIVEN ARE ROUND WEIGHTS FOR YELLOWFIN TUNA (GILLED), ALBACORE, AND SMALL TUNAS, AND DRAWN WEIGHTS FOR THE REMAINING SPECIES.
2/ INCLUDES ICED FISH AS WELL AS VERY SMALL FISH WHICH WERE WHOLE-FROZEN.
3/ ALLOWANCE GIVEN FISHERMEN FOR LOSS IN WEIGHT OF YELLOWFIN TUNA DUE TO REMOVAL OF GILLS.
4/ INCLUDES MISCELLANEOUS SPECIES SUCH AS DOLPHIN, WAHOO, AND BARRACUDA.

WORKING AND LIVING CONDITIONS OF THE JAPANESE FISHERMEN

With the available equipment and material on hand, the Japanese, after more than 60 years of experience, have introduced many changes which have increased the fishing potential as well as the handling efficiency of the tuna long-line gear. Despite these improvements, tuna long-lining remains one of the most strenuous and grueling methods of fishing practiced by the Japanese today. To a large degree this may be attributed to the fact that the Japanese boat owners prefer to use manual labor, rather than mechanize the operation to the fullest extent. Since the cost of labor in Japan is very low, it is the contention of the boat owners that it is far cheaper to use manual labor than to invest in mechanical equipment.

The setting of 50 to 60 miles of main line was accomplished in about 4 hours' time, while the retrieving operation required 10 to 14 hours of continuous work. In any fishing activity the entire crew participated, with each crew member working at high speed. The men received two rest periods of about 4 hours each during a fishing day. The first respite from work came in mid-morning after the line was completely set and the boat was drifting with the line. The second period of rest usually came after midnight upon completion of the retrieving operation and before the next set was made.

The crew's quarters in the long-line vessels were dirty, cramped, and ill-ventilated. On an inspection tour made of one of the vessels, it was observed that several bunks were of such diminutive size that the occupants were forced to sleep on their sides.

The men were fed on a budget of about 100 yen (28 US cents) per day per man. Rice and barley boiled together furnished the staple food. Dried vegetables, pickles, and non-perishables which keep for long periods of time under inadequate refrigeration were used to supplement the carbohydrate diet. Generally, only those fish damaged by sharks were used for consumption aboard the vessels.

The lack of sufficient quantities of fresh water caused one of the greatest discomforts aboard these vessels. The use of fresh water was limited strictly to drinking and cooking purposes. To give an idea of the scarcity of fresh water, it may suffice to mention that aboard certain vessels the use of fresh water for brushing teeth was forbidden by the captain.

No accurate information on the actual wages made by the crew members of the long-line vessels is available. However, fishermen who were interviewed claimed that they earned between 18,000 and 27,000 yen (US$50-$75) during a fishing trip of about a month's duration.

SUMMARY AND CONCLUSIONS

In Japan the production of tuna products has lagged far behind the ever-increasing demand. Moreover, the Japanese realize that the production in the coastal and offshore waters of Japan has already reached the practical maximum. Therefore, when the opportunity arose for the Japanese fishing industry to expand to the waters of the Trust Territory, they readily undertook the new venture.

These expeditions varied considerably in scale of operation. The largest expedition employed a mothership of 10,619 gross tons and a fishing fleet of 25 catcher vessels, while the smallest used a mothership of 577 gross tons and a fleet of 6 catchers. The periods of operation ranged from 24 to 84 fishing days and the areas of operation varied from 300 to 1,700 miles in the east-west direction and

from 240 to 500 miles in the north-south direction. Fishing vessels ranged in size from 56 to 196 gross tons, with a few of the smaller vessels being of wooden construction. The crews numbered from 16 to 54 men.

Since a large mothership was able to serve as storage and supply center for the fishing fleet, it enabled the expedition to remain at sea for a longer period of time and to operate in a wider area. The catcher vessel accompanying a small mothership, on the other hand, was forced to operate as a self-sufficient unit to a large extent, carrying most of its provisions, ice, bait, water, and fuel. The result was that such expeditions with small motherships were only able to be at sea for a relatively short time and to operate in a relatively small area.

The total catch by the six expeditions amounted to well over 20 million pounds of fish, with yellowfin tuna comprising more than 60 percent of this total. In terms of catch ratio, the average catch of tunas and spearfishes per 100 hooks per day for all six expeditions amounted to 3.70 fish. The fourth expedition achieved the highest ratio of 4.40, while the first expedition registered the lowest of 3.23.

The Taiyo Fishing Company and the Hoko Suisan Company directed much of their efforts toward obtaining fish for export, while the Nansei Fisheries Company supplied the home markets with fish.

Although adequate data are not available on which to base a conclusive statement on the financial success of these mothership-type tuna expeditions, the fact that the Taiyo Fishing Company has conducted two expeditions and that the Nansei Fisheries Company has undertaken three, can perhaps be taken as an indication of financial success. Moreover, these companies have indicated their desire to continue in this field.

Also from the point of view of the Japanese, these expeditions have been successful in the following aspects:

a. They have found it financially and operationally feasible to exploit distant waters for fish which are of insufficient abundance in the Japanese home waters;

b. They have given employment to thousands of fishermen and laborers during a period of critical work shortages in Japan;

c. They have served to relieve the congestion of fishing vessels operating in Japanese waters by enabling some to accompany the expeditions;

d. They have brought a means whereby the greatly increasing demand for tuna products at home can be supplied;

e. They have become a source of additional revenue for Japan by supplying fish to the export market.

ACKNOWLEDGMENT

This report has been made possible by the High Commissioner for the Trust Territory of the Pacific Islands, the Supreme Commander for the Allied Powers, and the Japanese Government. The cooperation shown by the personnel of the Fisheries Division, Natural Resources Section, SCAP; the Taiyo Fishing Company, and the Nansei Fisheries Company is gratefully acknowledged. Inspectors Tomio Kato, Kisaburo Honda, K. Ishizuka, H. Inouye, Hirosaku Koda, and Heihachiro Kawamura of the

Japanese Fisheries Agency, who served on these expeditions, have rendered generous assistance in the gathering of materials pertinent to this report. The sketches used in this paper were prepared by Mr. Tamotsu Nakata, draftsman for the Pacific Oceanic Fishery Investigations, U. S. Fish and Wildlife Service, Honolulu, T. H.

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Observations on a Specimen of Bluefin Tuna *(Thunnus thynnus)* Taken in Hawaiian Waters

FRED C. JUNE[1]

DISPLAY COPY

The bluefin tuna, *Thunnus thynnus* (Linné), has been reported from Hawaiian waters by several authors (Fowler, 1923 and 1928; Jordan and Evermann, 1926), however, it appears only rarely in the commercial tuna catches from this area. The last confirmed report of the occurrence of this species was a landing made by a commercial long-line boat off the coast of Waianae, Oahu, in 1939. There have been reports of bluefin tuna being taken along the Kona coast of the island of Hawaii, but they have been infrequent and the identifications were not validated.

On October 3, 1950, a specimen weighing 223 pounds was captured on long-line gear by the vessel *Ilima* while fishing off the southwest coast of Oahu, at approximately 21° 26′ N., 158° 27′ W. and at an estimated depth of 60 fathoms.

Measurements on this specimen were taken on October 6, 1950, at the Kyodo Fishing Co., Ltd., Honolulu, where the fish catch of the *Ilima* was unloaded for disposition. Viscera, for subsequent laboratory examination, were also obtained at this time. The various measurements, according to the methods described by Marr and Schaefer (1949), and meristic counts are given in Table 1 for the benefit of those interested in a critical study of the morphometric characters and distribution of this fish.

In all anatomical characters examined, this specimen agreed with Godsil and Holmberg's (1950) detailed description of the Pacific bluefin tuna, *Thunnus thynnus*. It also showed remarkable agreement with Kishinouye's (1923) description of *Thunnus orientalis*, except for the author's notation regarding the division of the ureter as it enters the kidney. Kishinouye (1923: 309) states, "In *Thunnus orientalis* the two ureters meet in a figure like U, and in other forms of the Japanese tunnies they meet like the figure V." In the Hawaiian specimen, the ureters met in a figure V at a point 31 mm. within the posterior margin of the kidney. The left branch continued anteriorly for a short distance, then diverged sharply, whereas the right branch curved outward gradually from the point of division. Both observations follow Godsil and Holmberg's findings for *T. thynnus*.

Another point of apparent difference between the description given by Godsil and Holmberg and that of Kishinouye concerns the branching of the coeliac-mesenteric artery. Kishinouye (1923: 378) indicates the presence of an abortive No. 1 branch in *T. orientalis*. He states, "In [the genus *Thunnus*] the first branch is abortive and nourishes the oesophagus only, or is entirely absent." Godsil and Holmberg (1950: 42) found no No. 1 branch in *T. thynnus* and conclude, "Occasionally a capillary-size vessel is present, originating approximately where the No. 1 branch should be, and like it running to the oesophagus. This vessel is so small, and is moreover one of several originating in this region and nourishing the adjacent tissues, that it was not considered homologous with No. 1 branch." There was no evidence of a

[1] Pacific Oceanic Fishery Investigations, Honolulu, Hawaii. Manuscript received May 11, 1951.

No. 1 branch in the Hawaiian specimen, but inasmuch as the circulatory system was not injected, this blood vessel may have been overlooked.

The coloration of the finlets in the Hawaiian specimen differed from descriptions for this form given by other authors. Both the dorsal and anal finlets were bright yellow with broad black borders, similar to those of the big-eyed tuna, *Parathunnus sibi*. Kishinouye (1923: 439) notes that in *T. orientalis* the dorsal finlets are yellow, whereas the anal finlets are silvery; both are without a black margin. Godsil (1945: 187) states that in *T. thynnus* ". . . the finlets, though frequently yellow, are not edged with black." Roedel (1948: 60) similarly remarks that *T. thynnus* "lacks . . . the black edging of the finlets found on the yellowfin tuna when caught." These discrepancies may be simply individual color variations that exist within the species or real differences that show variation with geographical distribution.

Until a more detailed comparison is made between *T. thynnus* from the eastern Pacific and *T. orientalis* from the western Pacific, the specific standing of these forms remains in doubt.

TABLE 1

MEASUREMENTS* AND MERISTIC COUNTS OF A SPECIMEN OF *Thunnus thynnus* FROM HAWAIIAN WATERS

Measurements	
Total length	1740
Head length	497
Snout to insertion first dorsal	531
Snout to insertion second dorsal	950
Snout to insertion anal	1069
Snout to insertion ventral	540
Insertion ventrals to anterior edge vent	560
Greatest depth	450
Spread caudal	561
Length longest dorsal spine	189
Length first dorsal spine	189
Length second dorsal	268
Length anal	251
Length longest dorsal finlet	59
Diameter iris	44
Length maxillary	25
Least depth caudal peduncle	47
Greatest width caudal peduncle at keels	144
Meristic Counts	
First dorsal spines	14
Second dorsal rays	15
Dorsal finlets	8
Second dorsal plus dorsal finlets	23
Anal rays	15
Anal finlets	7
Anal plus anal finlets	22
Gill rakers (first gill arch)	12+24

* Measurements are in millimeters.

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DISPLAY COPY

AN "UNUSUAL" YELLOWFIN TUNA (*NEOTHUNNUS MACROPTERUS*) FROM THE WATERS OF THE NORTHERN LINE ISLANDS IN THE CENTRAL PACIFIC OCEAN.—During an exploratory fishing cruise of the U. S. Fish and Wildlife Service vessel, HUGH M. SMITH, in waters of the central Pacific Ocean in May and June, 1951, a female tuna, weighing 24 pounds, was captured which differed distinctly from the fish being landed from a surface school of yellowfin tuna (*Neothunnus macropterus* Temminck and Schlegel). The specimen was caught by hook and line on June 1 while chumming off Palmyra Island, 1½ miles WSW of Sand Island, where water depths exceed 2000 fathoms.

The coloration of the fresh specimen was striking: the upper surface of the body was steel-blue, shading into silvery-gray on the sides and white on the belly; a series of oblique transverse pale silvery lines, alternating with similarly colored rows of dots, was present on the side, the latter forming an irregular pattern on the caudal peduncle; the first and second dorsals, anal, and caudal fins were dusky and edged with black; the anterior one-third of the pectoral fins was silvery-gray, shading into dusky posteriorly and edged with black; both the dorsal and

anal finlets were jet black; the body and fins were without yellow markings.

Based on these external color markings, the specimen at first appeared to be a bluefin tuna, either *Thunnus thynnus* (Linnaeus) or *Thunnus maccoyi* (Castelnau), except for the oblique transverse silvery bars on the sides of the body, the black finlets, and the pectoral fins; the latter are much longer than is common in either of these species of comparable size. Furthermore, the gill-raker count precluded its assignment to either of these species. Godsil and Holmberg (1950, Calif. Div. Fish and Game, Fish Bull. 77: 1–55) gave gill-raker counts for *T. thynnus* and *T. maccoyi* as 10 to 15 + 21 to 25, and 12 + 22 to 24, respectively. This specimen has a gill-raker count of 9 + 21 on the first gill arch of both the right and left sides, which is clearly within the range for the yellowfin tuna, *Neothunnus macropterus*. Also, the specimen differed from *Kishinoella tonggol* Bleeker, the latter having a gill-raker count of 5 to 8 + 14 to 17 (Serventy, 1942, Jour. Council Sci. and Ind. Res., 15 (2): 101–12).

Other meristic counts and measurements, after the methods of Marr and Schaefer (1949, U. S. Fish and Wildlife Service, Fish. Bull. 47: 241–44), were made aboard the vessel at the time of capture, and are presented in Table I. These measurements consistently fall within the range of variation for *Neothunnus macropterus* of comparable size, but lie outside the ranges for other tuna species for which there are published data.

An examination of the internal anatomy (made after three month's preservation in formalin) showed the following features: The apex of the caecal mass is located on the right side of the body, which appears to be rather uncommon in the tunas. The liver is composed of three lobes, the right lobe the longest. The central portions of all three lobes lack black striations on the ventral surfaces; however, these surfaces are marked inconspicuously with a very fine network of blood vessels on the central portions and along the edges. Furthermore, a swim bladder is present which occupies nearly two-thirds the length of the body cavity; in shape and size it is comparable to the descriptions of this structure in *Neothunnus macropterus* as given by Godsil and Byers (1944, Calif. Div. Fish and Game, Fish. Bull. 60: 54–57).

Based on the morphometric measurements, gill-raker counts, the plain ventral surfaces of the lobes

TABLE I

MEASUREMENTS, IN MILLIMETERS, AND MERISTIC COUNTS OF AN "UNUSUAL" SPECIMEN OF *Neothunnus macropterus* CAPTURED IN THE LINE ISLANDS IN JUNE, 1951

Total length (fork length)	863
Head length	241
Snout to origin of first dorsal fin	265
Snout to origin of second dorsal fin	459
Snout to origin of anal fin	504
Snout to insertion of ventral fin	276
Insertion of ventrals to anterior edge of vent	244
Greatest body depth	216
Pectoral fin, length	234
Pectoral insertion to origin of first dorsal	126
First dorsal, basal length	196
Second dorsal, basal length	93
Spread caudal (fin was frayed)	275
Longest dorsal spine, length	97
First dorsal spine, length	97
Second dorsal fin, length	136
Anal fin, length	140
Length longest dorsal finlet	32
Iris, diameter	36
Maxillary, length	97
Caudal peduncle, least depth	22
Caudal peduncle, greatest width at keels	80
Spines in first dorsal	14
Rays in second dorsal	14
Dorsal finlets	8
Rays in anal	14
Anal finlets	8

of the liver and the presence of a well developed swim bladder, the specimen tentatively is identified as an unusual *Neothunnus macropterus*.

Verbal information obtained from Mr. Phil Palmer, Manager of the Fanning Island Plantation, Ltd., indicated that tunas similar to that described above occasionally have been caught in the waters off Fanning Island. It is possible that the specimen represents a race that has become established in the Line Islands area. The specimen is preserved at the Pacific Oceanic Fishery Investigations laboratory as POFI Cat. No. 5314.—FRED C. JUNE, *U. S. Fish and Wildlife Service, Box 531, University of Delaware, Newark, Delaware.*